The Impact of CHaMP

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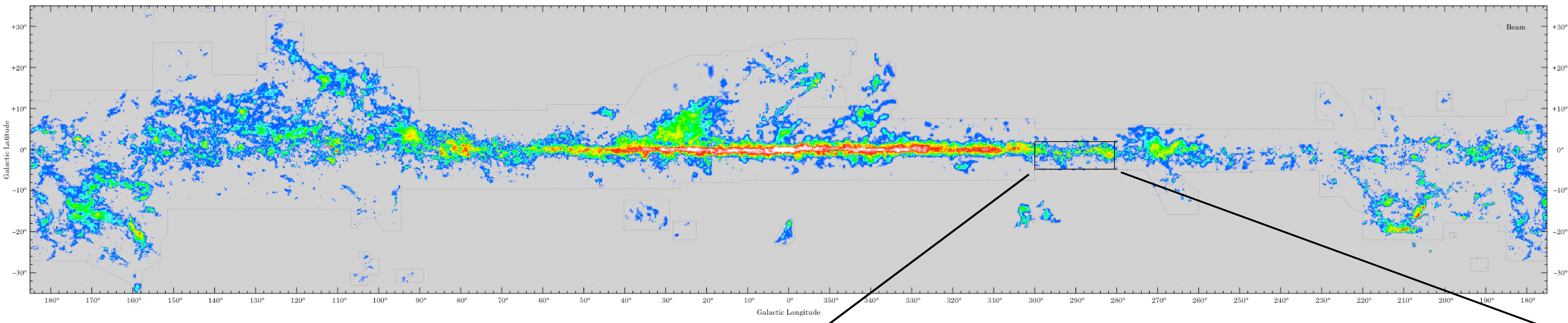
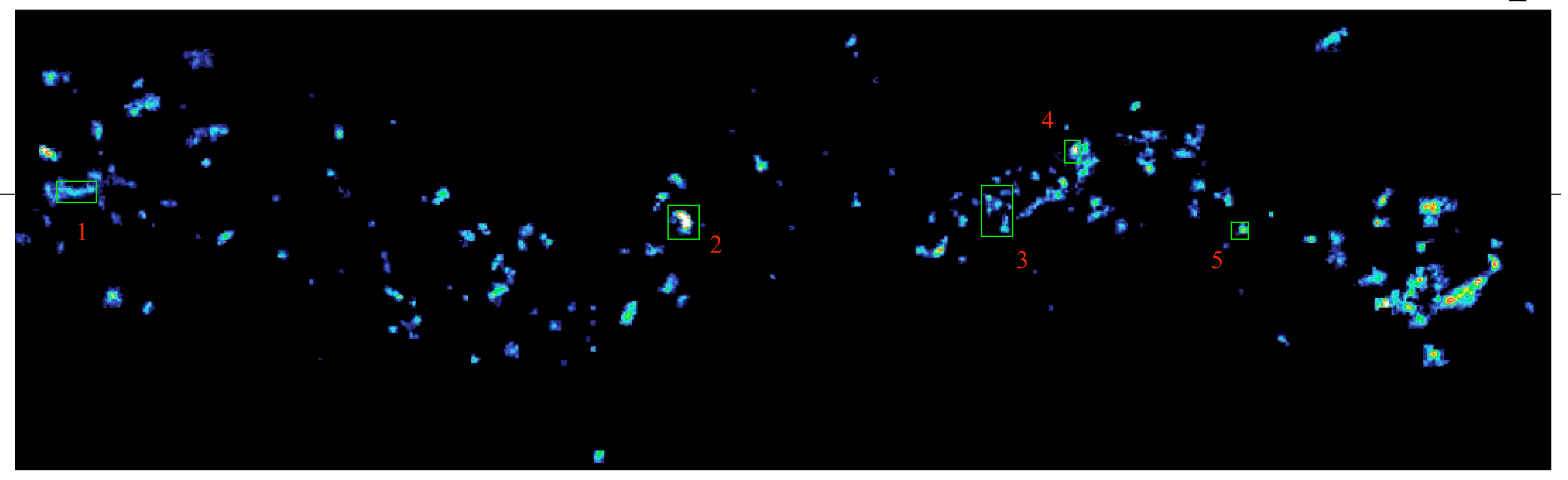
All-sky CO map from Dame et al. (2001). The box shows the location of the CHaMP survey region.



Description

The Census of High- and Medium-mass Protostars (CHaMP) is surveying the earliest phases of massive star formation by compiling the largest, most uniform, and least biased database of such regions at multiple wavelengths. We are bootstrapping from the Nanten Galactic Plane surveys using the 128k-channel digital filterbank on the Mopra antenna of the Australia Telescope, covering a 20°x6° region in Vela, Carina, and Centaurus at 36” and 0.1 km/s resolution. In 2005–07 we efficiently mapped over 100 cores in this region with multiple tracers, identifying all the dense gas, and we are now characterising their physical state (temperature, density, mass, luminosity, etc.). At the same time, we have begun near-IR imaging spectroscopy of these dense cores with the IRIS2 imager on the Anglo-Australian Telescope, and are also surveying the 1mm dust continuum with ASTE.



Integrated intensity of $C^{18}O$ emission from the Carina arm, mapped with Nanten. Boxes outline locations of sample Mopra maps shown in figures below.

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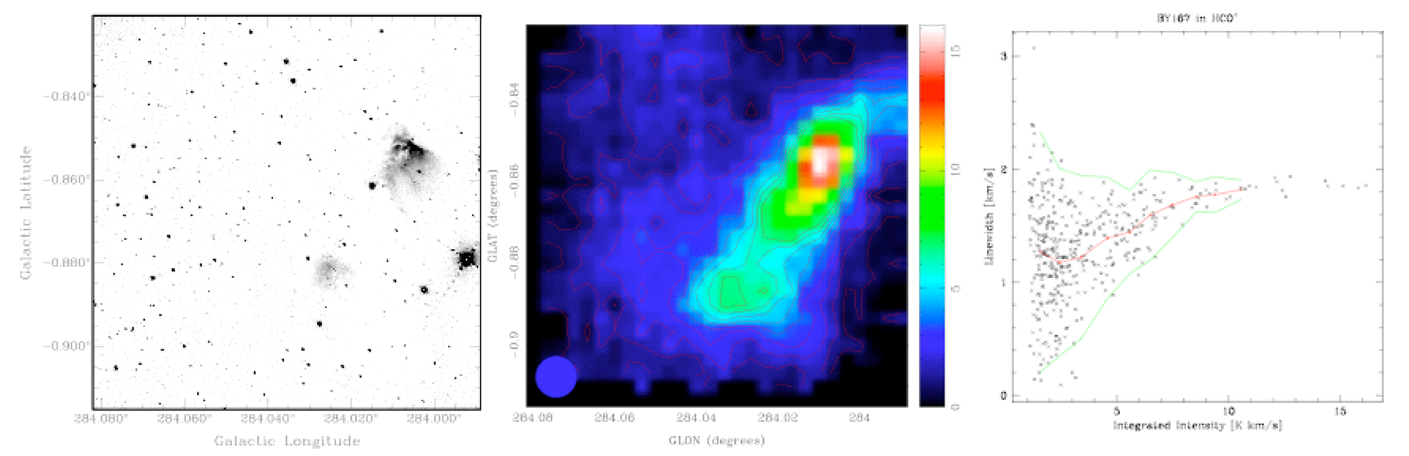
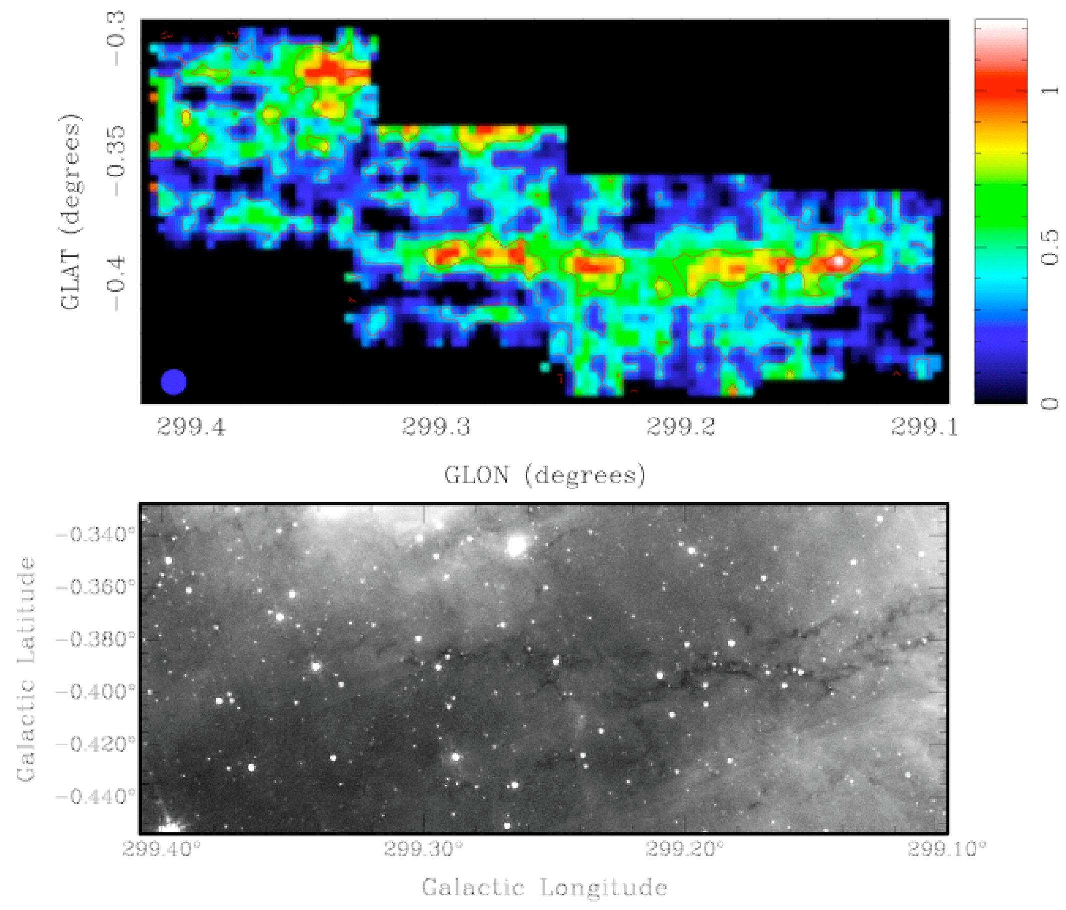


(Left) Continuum-subtracted Br-γ image of UCHII regions from the AAT. (Middle) Mopra HCO+ map of associated molecular core. (Right) Pixel-by-pixel comparison of HCO+ linewidth vs. brightness. Note the tight correlation, opposite to the usual Larson relations for low-mass cores.

1



(Top) Integrated intensity in the HCO^+ 1–0 line as ampped at Mopra, units of K km/s. (Bottom) GLIMPSE IRAC 8μm image of the same region

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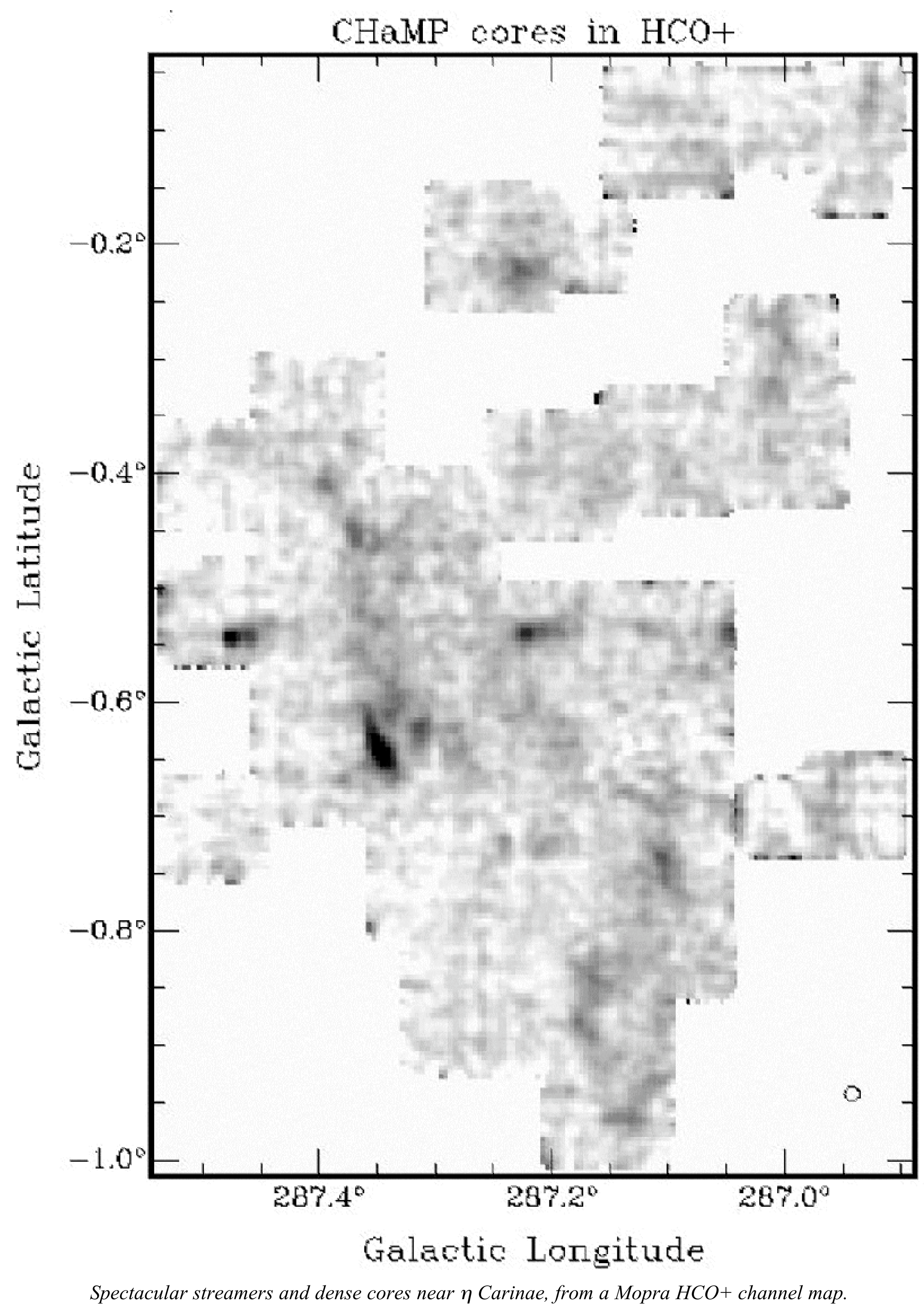
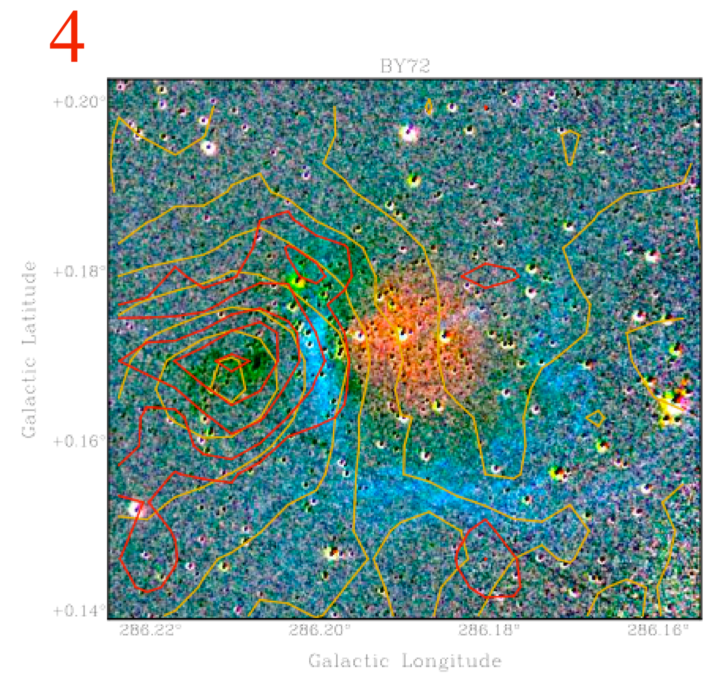


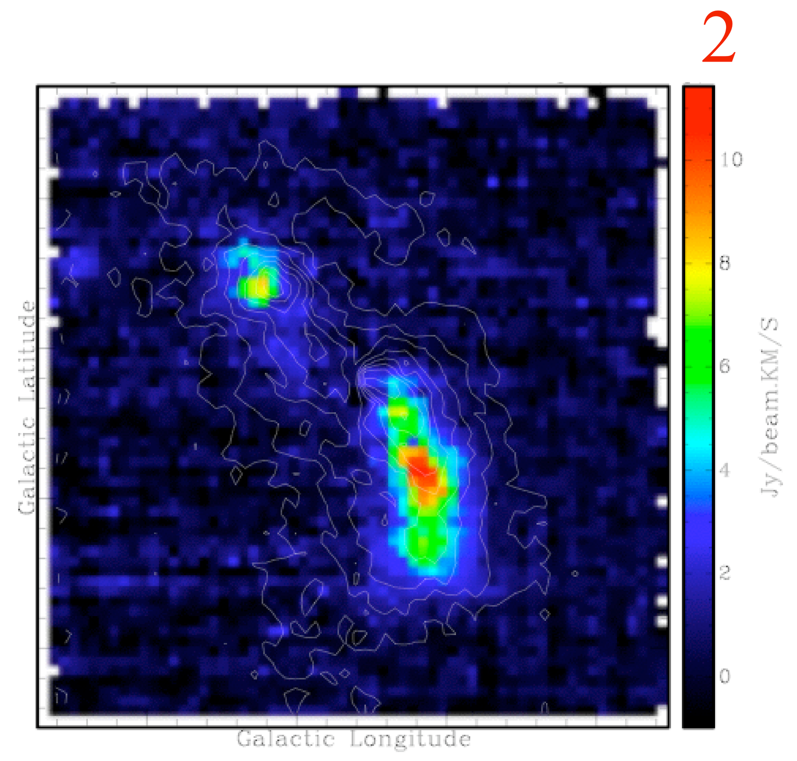
Spectacular streamers and dense cores near η Carinae, from a Mopra HCO+ channel map.

4



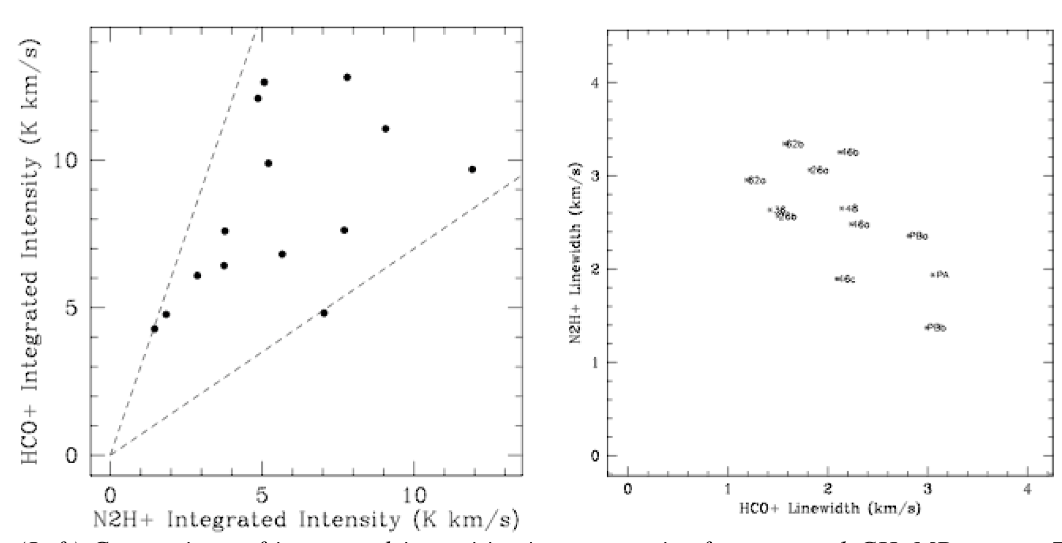
Overlay of a K-band pseudocolour image (red = continuum subtracted Br-γ, blue & green = continuum-subtracted H_2 S(0) v=2–1 and 1–0) with Mopra HCO+ & $H^{13}CO^+$ contours, of a dense core showing evidence of large-scale gravitational collapse.

2



Mopra N_2H^+ integrated intensity image overlayed with contours of HCO^+ integrated intensity. Note the clear difference in these two species' peak positions indicating chemical inhomogeneity in the dense gas.

All



(Left) Comparison of integrated intensities in two species from several CHaMP cores. The HCO+ to N_2H^+ ratio varies among these cores by a factor of 4. (Right) Comparison of HCO+ and N2H+ linewidths in the same cores. Note the striking anticorrelation. Both of these features suggest a strong chemical and dynamical difference in what these two species trace in the dense gas, which must be addressed by theory.

Preliminary Results

Our first results suggest that, if all cores sampled make up a single population whose differences are due mostly to evolutionary effects, then the dense core phase ($n > 10^5$ cm^{-3}) of a molecular cloud only lasts ~15–25% of the lifetime of the GMC itself. Furthermore, under the same assumptions, the incidence of infall is so low that it must last only ~4% or less of the lifetime of a GMC.

The Future

These data will allow us to take an unbiased census of all massive protostars and protostellar clusters in our 20°x6° survey region on both large and small scales, as well as identifying massive starless cloud cores, and for the first time

(a) uniformly identify the normal evolutionary stages of higher-mass star formation,

(b) characterise the physical conditions in the dense gas at each stage,

(c) directly compute the lifetimes of each stage, and

(d) compare these results with other biased surveys.

While we plan to further expand the survey's scope and coverage, in a companion talk to this poster Jonathan Tan considers the impact CHaMP will have on studies of massive star formation with ALMA and other instruments, potentially providing definitive answers to many of the questions on this meeting's wish list.